

TECHNOLOGICAL ASPECTS OF REWORK

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Abstract: The paper deals with the technological aspects of rework. There are introduced some of these aspects as ambient temperature and ambient humidity, handling and storing devices and components, operators work, reflow soldering thermal profile, influence of flux. Technological aspects negatively influence reliability of soldering process, it is important to pay close attention to this phenomenon. They also have negative influence on repair yield.

1. INTRODUCTION

Rework can be explained as repair process which leads to elimination and correction of component defects in printed circuit board (PCB). Goal is to restore the product or the device back to operational status. The way how to achieve proper repair depends on the character of the product and the repair process. It is not necessary to introduce certain standards for the repairs of a low product quantity, but in the case of high product quantity it is a basic assumption for profitability of rework. Standards can positively affected repair yield. Repair yield tells us about success of repair process (e. g. 10 repaired units and 2 are not working means the yield is 80%).

2. TECHNOLOGICAL ASPECTS OF REWORK

It is good to follow technological aspects of rework to ensure reliable repeatability of results which leads to higher yield. The most important aspects associated with rework are listed below.

2.1. AMBIENT TEMPERATURE

Ambient temperature is important factor in repairing process. The problem is that soldering profile has to be set quite accurately, a few degree deviation can make a temperature profile completely unsatisfactory. It is exposing, if it is not possible to measure the temperature in real time during the reflow operation, system is working on the basis of variable time. If the ambient temperature is different from the default temperature, it can leads to overheating of the PCB or the appropriate temperature is not reached. The solution must include monitoring of the external temperature, in case of major change of the temperature a new profile has to be created. Professional solution is to provide such an area where the stability of key parameters (temperature, humidity, low level of dust) are guaranteed, it leads to improving yield.

2.2. AMBIENT HUMIDITY

Humidity is parameter link to the temperature. If the temperature is increasing the humidity is increasing as well, if the temperature is decreasing, humidity is decreasing too. Humidity accumulated in components can adversely affect the quality of the joint, or it can damage component or PCB. The solution is drying components according to the standard in the dry cabinet. Humidity also affects phenomena of electrostatic discharge (ESD). Humidity below 30% cannot be considered as appropriate area for ESD sensitive components.

2.3. HANDLING AND STORING

Handling and storing components has to be ensured for reliable repair process, it especially includes Moisture Sensitive Device and (MSDs) and ESD sensitive components. Procedures for handling and storing components are regulated in standards. Compliance of the defined parameters in standards produces economic requirements, their implementation also conducts benefits in financial perspective. For debugging factors causing procedural mistakes can be excluded a situation when the error discovered during testing is not caused by an incorrectly set process parameters, but it relates with improper handling and storing of the components or products. Handling and storing is an appropriate question, even though it is not a “primary” technological aspect.

2.4. REWORK OPERATOR

Operator work can be considered as variable factor in rework. If human factor is entering the process, it is necessary to expect possibility of mistakes or inaccurate execution of the operations. Better training for operators can contribute to further increasing of repair yield.

2.5. REFLOW SOLDERING THERMAL PROFILE

Reflow soldering is a process in which a solder paste is used to permanently attach one or more electrical components to their contact pads. High temperature has to be used for achieving permanent connections. There are two input parameters of the thermal profile, it is the time and the temperature.

There are known two types of soldering processes Ramp to Spike (RTS) and Ramp Soak Spike (RSS). RTS also called as “tent profile” is used for low capacity components. RTS allows shorter reflow process and allows used less chemical consumption to reduce oxides and assumes better flux activity. RSS is used for high capacity components. To identify which temperature profile is better for a particular application is always individual decision of the competent employee.

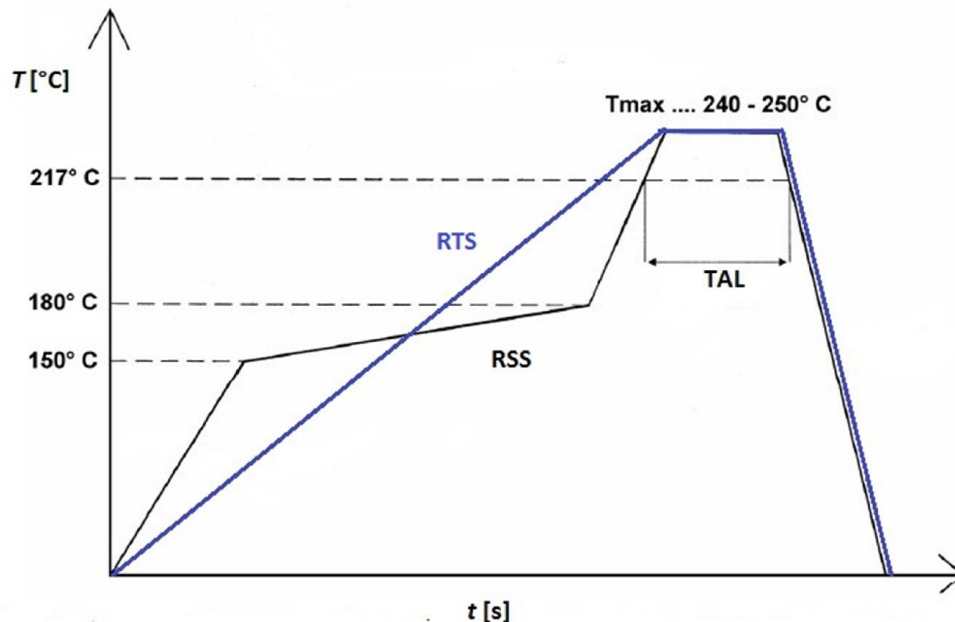


Figure 1: Reflow soldering thermal profile RSS and RTS

Thermal profile can be considered as one of the most important parameters for creating high quality connections and can achieve higher yield. The goal of the reflow process is to make a high quality solder joint without overheating or damaging electrical components or PCB. The soldering process has four stages, called “zones”.

- Preheat zone – is often the longest one and it established the ramp-rate. The ramp-up is usually between 1°C and 3 °C per second. If the rate exceeds maximum slope, it can damage the components from thermal shock. The solvent in the paste starts to evaporate in the preheat zone. Evaporation of flux volatiles can be incomplete if the rise rate is low level.
- Thermal soak zone – is typically a 60 to 120 seconds exposure for removal of solder paste volatiles and activation of flux. Flux begins oxide reduction on component leads and pads. Improper adjustment of temperature leads to solder splattering (high temperature) or flux is not fully activated (low temperature). At the end of the soak zone a thermal equilibrium of the entire assembly is in the desired state to move to reflow zone.
- Reflow zone – is the part where the maximum temperature is reached. We are speaking about time above liquid (TAL). TAL measures how long the solder is liquid, it is supposed to be around 60 seconds. Temperature for liquid solder (lead-free) is between 245 °C and 250 °C, but the PCB temperature has to be below 200 °C. It is due to safety of other components as pins or connectors (plastic material).
- Cooling zone – is gradual cooling of processed PCB and solidify the solder joints. Proper cooling inhibits excess intermetallic formation or thermal components shock. Best cooling rate is around 4 °C per second. Ramp-down rate is often ignored. A fast rate creates a fine grain structure.

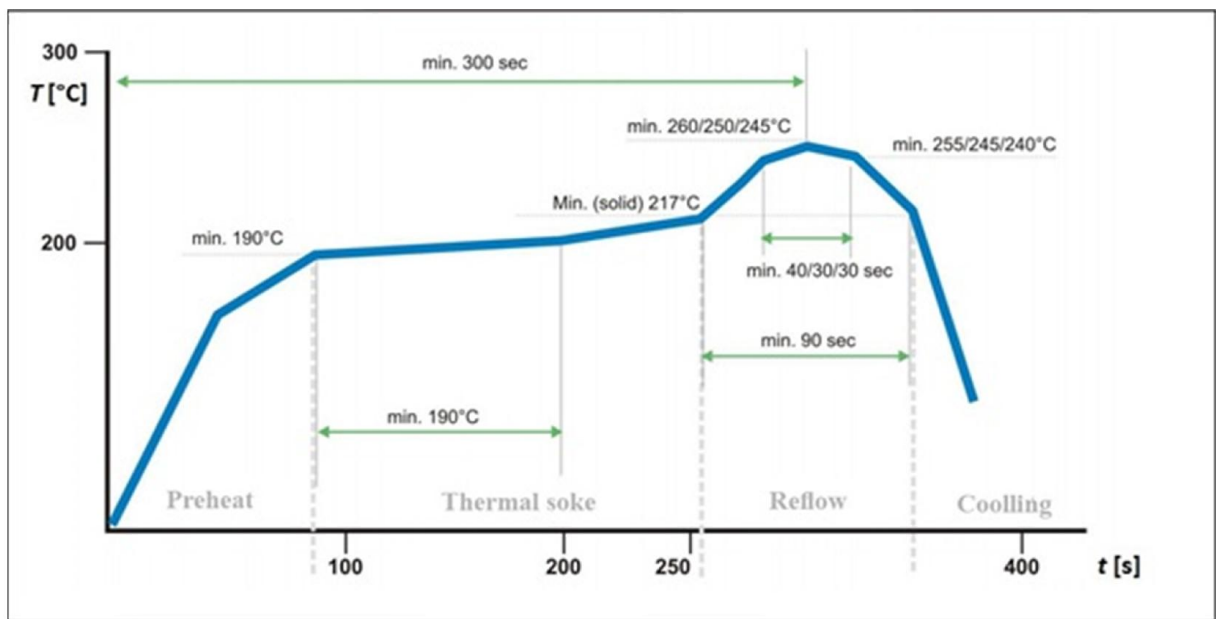


Figure 2: Zones in reflow soldering thermal profile

Setting temperature profile is an important part of correct reflow process. In BGA packages is a profile set by thermocouples placed instead of solder balls (three of them). Small holes are drilled into the board, through them are passing thermocouple wires. Thermocouples measure temperature in the middle and in two opposite corners, these thermocouples show temperature divergence between corners, it is desirable to minimize the temperature divergence. In case of minimum divergence there is an evenly warming of the package, which protects heat stress and possible mechanical damage.

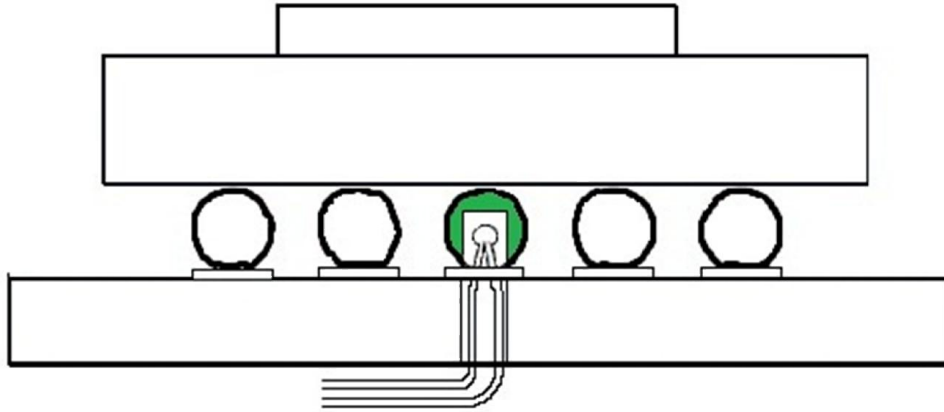


Figure 3: Principle of setting temperature profile

2.6. FLUX

The purpose of a flux is to facilitate soldering process. Impurities are obstacles for successful solder joints. The impurities can be removed by mechanical cleaning or chemical means, but it needs the solder melted. Flux accelerated soldering temperature and prevents oxidation. More aggressive fluxes are applied to achieve a better wetting during soldering lead free alloys. It is necessary to select the correct type of a flux to approve the proper reflow process and achieve stable solder-ability of all solder balls.

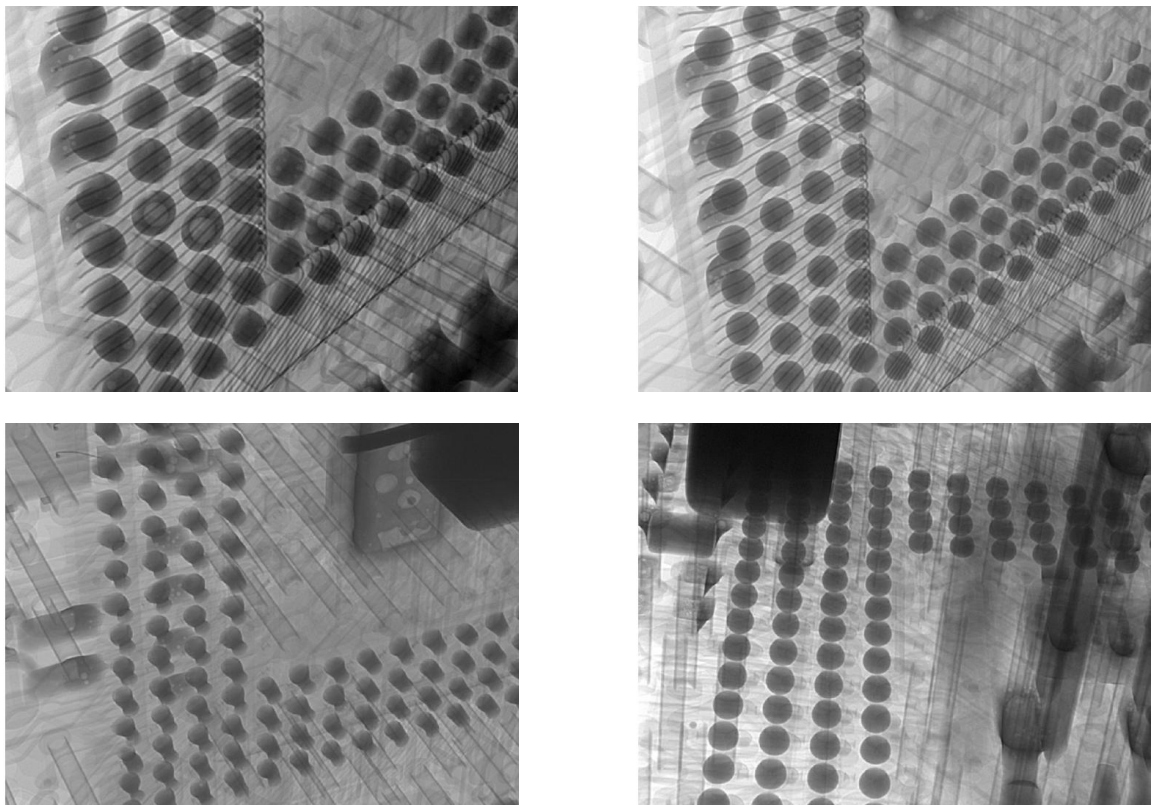


Figure 4: Top left: Excessive voiding within joints are seen, flux does not manage thoroughly evaporate.

Top right: Misalignment, package floated off, large volume of flux was applied.

Bottom left: Solder joints pulled off, large volume of flux caused lifting of package.

Bottom right: Open joints, not enough flux was applied, wetting is missing.

It is obligatory to find the most appropriate method of applying flux with correct quantity and analyze different flux types and their properties. Inappropriate methods of using flux leads to defects. Several defects are imaged in Figure 4. It includes excessive voiding, misalignments, open joints, etc. Excessive quantity of flux can cause voiding, misalignment or pulled off solder joints. Flux shortage can cause non-wettability (e.g. open joints).

3. CONCLUSION

This paper deals with technological aspects of rework. The PCBs are complicated and the components are miniaturized, that conduct new types of negative influences. Known negative influences have a greater impact than ever before. Effects have to be monitored separately and thoroughly. Some aspects are reduced easily and some aspects provide more difficulties. Rework goal is to achieve the highest possible degree of reparability and yield. The paper tries to highlight problems related to problematic of repairing boards.

ACKNOWLEDGEMENT

Funding for this research work is supported through grant project of the Czech Ministry of Education for Brno University of Technology FEKT-S-14-2168 “Research of modern and innovative technologies for packaging and interconnection in microelectronics”. This work is created with support of the Sanmina-SCI Corporation.

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